PACIFIC SOUTHWEST
Forest and Range
Experiment Station

FOREST SERVICE
U.S.DEPARTMENT OF AGRICULTURE
P.O. BOX 245, BERKELEY, CALIFORNIA 94701

THINNING PROMOTES GROWTH OF SPROUTS ON OLD-GROWTH REDWOOD STUMPS

Kenneth N. Boe

LIBRARY FILE COPY

USDA Forest Service
Research Note PSW-290
1974

Abstract: Sprouts 4 to 5 years old on old-growth redwood *(Sequoia sempervirens* [D. Don] Endl.*)* stumps were thinned at three levels: no thinning, moderate, and heavy. After 5 years, sprouts more than doubled in diameter when heavily thinned, and increased by one-half when moderately thinned. The response to thinning was essentially alike for all sprouts on all stump sizes. Resprouting did not reduce the accelerated growth of crop trees. The cubic volume of crop trees per stump unit that were moderately or heavily thinned exceeded that of crop trees that were not thinned, but was less than that for all trees left unthinned. The results suggest that thinning can be used as a technique to optimize size and wood volume in redwood.

Oxford: 174.7 *Sequoia sempervirens:* 231.4: 242.
Retrieval Terms: Sequoia sempervirens; sprout thinning; diameter increment; Redwood Experimental Forest.

Sprouts grow from dormant buds around root collars and along sides of many stumps of cut redwood *(Sequoia sempervirens* [D. Don] Endl.*)*. Often the sprout clusters are dense. Now that intensive silviculture is being emphasized, thinning may help increase growth on selected crop-tree sprouts. Such sprouts are destined to form the main crop of trees at intermediate and final harvests.

Trees of sprout origin comprise a significant proportion of the young stands after the harvest of old-growth—55 percent, according to Lindquist and Palley.[1] Stands that develop after the harvesting of young-growth could have an even higher percentage of crop trees of sprout origin. Where management dollars must be economically spent, the forester needs to know whether sprout thinning is a silviculture practice that will likely enhance growing of timber. He needs answers to such questions as: How will growth of thinned sprouts compare with similar sprouts in unthinned clusters? Would release effects diminish within a few years after thinning? Would thinned sprouts be subject to high mortality?

To seek answers, I did a study of thinning of 4- and 5-year-old sprouts on high-site land on the Redwood Experimental Forest, Del Norte County, California. The results, for a 5-year period, suggest that thinning promotes the diameter but not height growth of crop trees, and that this technique may be a useful one to optimize size and wood volume.

METHODS

The sprouts were 4 and 5 years old and of a size that easily permitted selection of dominant sprouts yet did not require an excessive thinning job. Crop tree sprouts were 0.4 to 4.3 inches d.b.h. and 7 to 24 feet tall. Other sprouts were usually smaller, and varied from about 20 to 400 per stump. Only sprouts growing from the root crown were chosen for the crop trees because they were considered most likely

to withstand storm breakage and most favorably located for normal bole development. Furthermore, since stumps varied greatly in size, the study included a comparison of growth of sprouts on stumps under 60 inches with that for stumps more than 60 inches in diameter. The question was: Would the larger root system of the larger older stumps affect sprout growth differently than would smaller root systems?

Three levels of thinning—moderate, heavy, and no thinning—were tested in a randomized block design with three replications. Each thinning level and replication had 10 or more crop tree sprouts for measurement. In each replication, stumps were selected in sets of four that were similar in diameter, sprout density, and circumferential span of sprout clusters. By random choice, each of the stumps in a set was assigned a level of thinning—two had to be heavy to have at least 10 sprouts for measurement.

In the stump-size group of less than 60 inches, three sprouts were tagged on each unthinned stump, three left on each moderately thinned, and one left on each heavily thinned stump. On each set of stumps more than 60 inches, five sprouts were tagged on each unthinned stump, five left on each moderately thinned, and two on each heavily thinned stump. The crop tree sprouts were spaced two or more feet apart. On the thinned stumps, all sprouts except crop trees were cut. Diameters and heights were measured at 1, 2, and 5 years after thinning. I also recorded observations on mortality and on resprouting.

RESULTS

Stump Size and Sprout Growth

Do sprouts on the smaller stumps grow differently and respond differently to thinning than those on larger stumps? To test the null hypothesis that the means for sprout diameter growth and for height growth did not differ between the two size groups, I did "t" tests between means in each of several categories. Where the "t" values corresponded to probabilities of 5 percent and smaller, they were considered statistically significant, and the two means were judged to be truly different *(table 1)*.

Since the means of only one pair was significantly different, I concluded that redwood sprouts on old-growth stumps of all sizes have essentially similar growth patterns and respond similarly to thinning. Therefore, I combined the data for the two stump-size groups within each replication and analyzed the impact of treatments on diameter and height growth.

Thinning Effects

Thinning of crop-tree sprouts significantly increased diameter growth for 5 years as determined by analysis of variance. Furthermore, by the Tukey test, I found that the growth of sprouts heavily thinned was significantly greater than those moderately thinned and unthinned, but that growth of moderately thinned sprouts was not significantly greater

Table 1—*Five-year differences between sprout height and diameter growth on large and smaller stumps, for unthinned and heavy thinning and two replications*

Sprout growth, treatment and replication (R)	Stump diameter group		"t" values
	<60 inches	>60 inches	
Height growth			
Unthinned (RI) ..... ft.	12.4	11.5	0.399
Unthinned (RIII)[1] ..... ft.	8.5	11.5	[2]2.005
Heavy thinning (RI) ..... ft.	13.0	15.3	1.532
Heavy thinning (RIII) ..... ft.	9.2	11.6	1.545
Diameter growth			
Unthinned (RI) ..... in.	2.31	2.54	.508
Unthinned (RIII) ..... in.	3.05	3.09	.065
Heavy thinning (RI) ..... in.	5.05	5.90	[2]2.746*
Heavy thinning (RIII) ..... in.	4.73	5.98	1.630

* Statistically significant at the 5 percent level of probability.

[1] Replication II not included because of incomplete data for heavy thinning in the diameter group >60 inches.

[2] "t" test made using Cochran's approximation because variances were dissimilar; in all other tests, variances were alike.

than unthinned sprouts. The 5-year mean diameter growth of crop tree sprouts was:

	Diameter growth (inches)
Treatment:	
Unthinned	2.65
Moderately thinned	3.78
Heavily thinned	5.71

Again, using analysis of variance, I found that effects of thinning on 5-year height growth of crop tree sprouts was not significant between unthinned, moderate, or heavy thinning treatments. The 5-year mean height growth was:

	Growth (feet)
Treatment:	
Unthinned	11.5
Moderately thinned	10.2
Heavily thinned	13.0

Mortality

Natural mortality of crop-tree sprouts due primarily to weather was low during the 5 years after thinning. The sprouts receiving heavy thinning had the highest mortality, but this rate was only 6 percent more than that for the unthinned sprouts:

	Unthinned	*Moderately thinned*	*Heavily thinned*
		(percent)	
Sprout Condition:			
Alive	94	91	88
Dead:			
Unknown	3	–	4
Dessicated	–	–	4
Detached	–	9	4
Broken	3	–	–

This level of mortality does not appear to be great enough to be a major deterrent to thinning.

Impact On Growth From Resprouting

Many of the sprouts cut in thinning started growing again. And although they are much smaller than the crop-tree sprouts, they do appear to provide competition. I tested both height and diameter growth of the crop trees by the "t" test to evaluate growth impact by these new sprouts. For this analysis two levels of resprouting were designated: (1) 0 to five new sprouts per stump; and (2) more than five new sprouts. Only the growth for the last 3 to 5 years was considered because I assumed that during the first 2 years after thinning the new sprouts would be small, therefore, offer only minor competition. Effects of heavy thinning were analyzed separately from those for moderate thinning. Neither height growth nor diameter growth for both moderate and heavy thinning treatments was significantly different regardless of number of new sprouts:

	New Sprouts		*"t" values*
	0 to 5	*>5*	
Height growth			
Moderate thinning–ft.	7.1	8.0	0.80
Heavy thinning–ft.	8.0	8.6	.58
Diameter growth			
Moderate thinning–in.	2.1	2.4	1.10
Heavy thinning–in.	3.3	3.2	.37

Growth Levels and Trends

Annual mean height growth during the first, second, and third to fifth years, and between the different thinnings was satisfactory and mostly similar on all thinnings *(fig. 1)*. A small increase in the annual rate occurred during the third to fifth year for both the thinned and unthinned sprouts. Presumably this increase could be due to favorable weather or to a normal increase associated with the 7- to 10-year-old redwood sprouts.

The annual diameter growth retained consistent differences among the unthinned, moderate, and heavy thinning treatments for the first, second, and third to fifth years *(fig. 1)*. This relationship illustrates that the release effects of thinning are continuing, although all growth showed a downward trend of annual rate in the third to fifth years. For reasons not determined in this study, diameter growth trends were opposite to those for height growth.

These height and diameter growth results are difficult to compare to Barrette's[2] results for sprout thinning because he measured growth on unthinned sprouts during only the last two of a 15-year period. Furthermore, the level of thinning was probably different because on one of his sample stumps, 51 sprouts were left after thinning but only the seven tallest were measured. Height growth in the two studies were similar, and differences between thinned and unthinned sprouts were only slight.

The differences, especially between heavily thinned and unthinned crop-tree sprouts, become greater when expressed in cubic volume than in diameter growth. For the average crop tree, the cubic feet volumes of boles from a 1.5-foot stump up to a 2-inch top d.i.b. were:

Treatment:	Year		
	First	*Second*	*Fifth*
Unthinned	0.08	0.16	0.77
Moderately thinned	.00	.06	.96
Heavily thinned	.15	.40	2.63

Labor to Thin

Labor for sprout thinning apparently will be fairly great per stump unit because of difficulty of moving around the stumps on steep, rough ground, the vegetation hindrances, and the rather large numbers of sprouts on many stumps. The field time for the actual thinning ranged from 0.15 to 1.25 man-hours per stump and averaged about 0.5 man hours. Add the travel time between stumps, rest time, etc., and the production per man day will be only about 12 to 14 stumps (or 1 to 3 acres based on our stocking of 4 to 12 sprouting stumps per acre). These old-growth stumps range from 2 to 10 feet in diameter and have a span circumference of sprouts (about 20 to 400 in number) at the base ranging from 6 to 27 feet.

A pruning saw and lopping shears were more useful than an axe, brush axe, or bow saw. It was easier to thin where there were fewer larger sprouts than many small sprouts.

DISCUSSION

Throughout the redwood region are thousands of harvested acres on which are many sprouting old-growth redwood stumps per acre. Sprouts contribute half or more of the usable volume on many acres of the young stands that have grown after old-growth trees were harvested. Therefore, forest managers should carefully consider as an investment, thinning that accelerates wood increment on the sprout crop trees. The moderately and heavily thinned sprouts maintained much faster diameter growth than crop tree sprouts on unthinned stumps and produced average larger trees in 5 years:

Treatment:	*Diameter (inches)*
Unthinned:	
Crop sprouts	4.6
Other sprouts	3.4
Moderately thinned	5.5
Heavily thinned	8.0

These findings suggest that this growth superiority will continue, perhaps even become greater, in the next few years *(fig. 1)*. Therefore, the cost of thinning needs to be balanced against the increased values

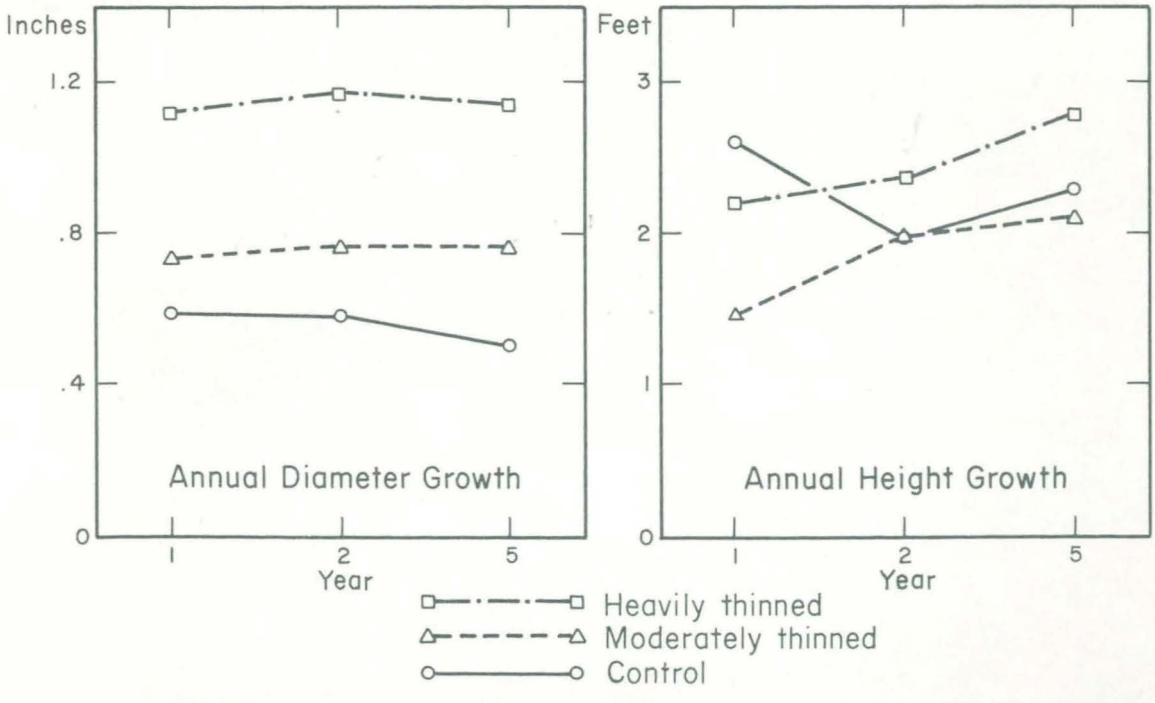

Figure 1--For redwood crop tree sprouts, average annual height growth for three time periods was similar between unthinned and two levels of thinning treatment, but diameter growth was consistently different.

accrued by growing larger trees in a short period of time.

If optimizing sprout size and wood volume is the objective, however, then a moderate to heavy thinning would appear to be the choice. The volumes (cubic feet) of sprout crop trees for one set of similar stump units one period after thinning were:

	5 years after thinning
Treatment:	
Unthinned:	
Five crop sprouts	3.85
Twelve other sprouts	3.81
Moderately thinned:	
Five crop sprouts	4.80
Heavily thinned:	
Two crop sprouts	5.26

In addition to setting the sprout thinning level, the forest manager must also select the effective stand improvement work for the remainder of redwood and other conifers of seed origin on each acre to optimize forest growth.

NOTES

[1] Lindquist, James L., and Marshall N. Palley. *Empirical yield tables for young-growth redwood.* Univ. Calif. Agric. Exp. Stn. Bull. 796. 47 p., illus. 1963.

[2] Barrette, Brian R. *Redwood sprouts on Jackson State Forest.* Calif. Div. For. State Forest Notes 29. 8 p., illus. 1966.

The Author

KENNETH N. BOE is conducting studies in the silviculture of redwood and associated species, with headquarters at Arcata, California. Native of Montana, he earned bachelor's and master's degrees in forestry at Montana State University. He joined the Forest Service's experiment station in California in 1956.

The Forest Service of the U.S. Department of Agriculture

. . . Conducts forest and range research at more than 75 locations from Puerto Rico to Alaska and Hawaii.

. . . Participates with all State forestry agencies in cooperative programs to protect and improve the Nation's 395 million acres of State, local, and private forest lands.

. . . Manages and protects the 187-million-acre National Forest System for sustained yield of its many products and services.

The Pacific Southwest Forest and Range Experiment Station

represents the research branch of the Forest Service in California and Hawaii.

G. P. O. 794–473/4623